



# The Center for Separations Using Thin Films (CSTF)

University of Colorado at Boulder

***Thin films offer new separation techniques that will save money and energy for industry***

## Center Mission and Rationale

Separation processes constitute a large segment of materials processing in the chemical, petrochemical, and gas separation industries. The cost of separation can represent as much as 80% of the total processing costs, especially for commodity chemicals. A wide range of separation issues are of increasing concern to the pharmaceutical, semiconductor, and food and beverage industries. Utilization of polymeric, ceramic, and metallic thin films offers new possibilities for efficient separations with a resulting impact on the user-industry's capital, operating, and energy-consumption costs.

CSTF was established to advance the technology of thin film separations. The main objectives of the Center are to —

- Conduct basic research and related developmental activities using thin film technology in separation processes
- Provide timely and effective technology transfer between the Center and its industrial participants
- Promote graduate studies of thin film technology.

## Research Program

Faculty and students from the departments of chemical engineering, civil, environmental, and architectural

engineering, mechanical engineering, chemistry, and physics at the University of Colorado and the department of chemical engineering at Colorado School of Mines, and the Denver Research Institute conduct research at CSTF in four major areas: chemically enhanced separations, membrane structure and performance, membrane fouling, and catalytic membrane reactors.

In the area of technology transfer, the Center's milestone achievements include:

- Three patents allowed for sulfur-tolerant complexing agents for olefin separations
- Patent allowed for modified ion-exchange membranes
- Patent allowed for convective liquid crystal membranes
- Patent allowed for production of novel molybdenum-sulfide dimers
- Collaboration with the Chevron Research and Technology Company on the development of sulfur-tolerant complexing agents
- Collaboration with Chevron Research and Technology Company on zeolite membranes and chemically specific membranes for olefin separations.

The Center has exceptional facilities and equipment for characterizing thin films and evaluating the perfor

A National  
Science  
Foundation  
Industry/  
University  
Cooperative  
Research  
Center  
since 1991



Center Co-Director Dr. William B. Krantz examines membrane morphology using the Center's high-resolution scanning electron microscope.

mance of thin film separation devices. The following analytical tools are available:

- Scanning and transmission electron microscopy
- Infrared thermal video imaging
- High-pressure liquid chromatography
- Differential scanning calorimetry
- Thermal gravimetric analysis
- Ellipsometry
- Temperature programmed reaction systems
- Low- and high-pressure membrane flow systems
- Acoustic reflectometry
- Static chemisorption system
- Dynamic mechanical analyzer
- Various spectroscopies, including Auger electron, x-ray photoelectron, wavelength dispersive x-ray energy dispersive x-ray, high-resolution electron energy loss, nuclear magnetic resonance, high resolution mass, automatic x-ray, Fourier transform infrared, and low energy electron diffraction.

#### Special Center Activities

CSTF sponsors an NSF *Summer Research Experiences for Undergraduates Program in Membrane and Thin-Film Science*, with a special focus on providing research opportunities for women and minorities. The Center also has established a Colorado Small Business Showcase and Undergraduate Summer Internship Program.

Highlights of other recent CSTF activities include:

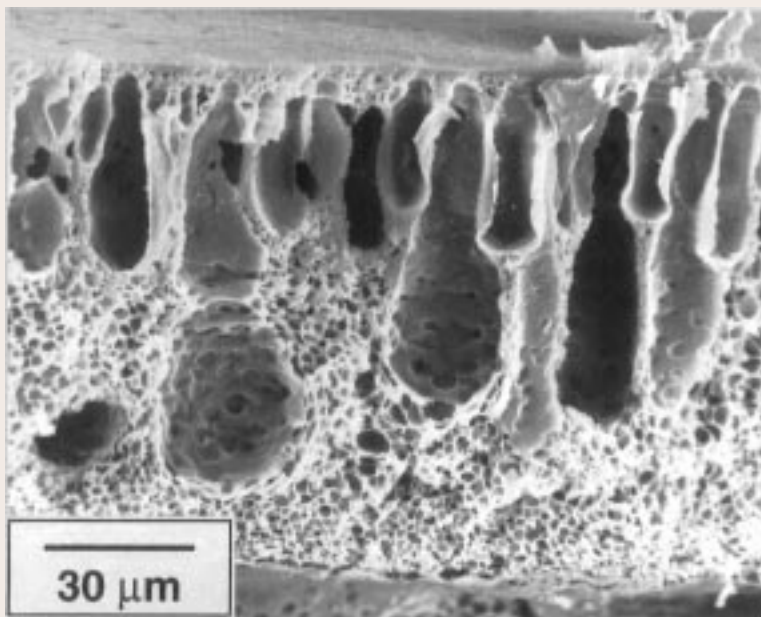
- Stimulating 13 cooperative interdisciplinary research projects
- Enlisting 18 faculty spanning 8 departments at 4 universities
- Facilitating a graduate research program in which approximately 15 doctoral and



Center Co-Director Dr. Richard D. Noble lecturing in the new course entitled *Chemically Specific Separations*, which was stimulated by Center research.

- post-doctoral students participate per year
- Providing research opportunities for more than 60 undergraduates
- Developing new courses on *Chemically Specific Separations* and *Introduction to Membrane Science*
- Sponsoring the 1994 Annual Meeting of the North American Membrane Society
- Sponsoring research resulting in two North American Membrane Society Graduate Fellowships
- Hosting visiting postdoctoral fellows, international professors, and industry scientists
- Interacting with two other I/UCRCs via TIE projects

- Establishing an international exchange program with the Center for Membrane Science and Technology at the University of Twente, Netherlands
- Interacting with two CSTF industry sponsors via NSF's GOALI program.



Scanning electron micrograph of a cellulose acetate membrane, showing the complex morphology that controls its separation and permeation behavior

#### Center Headquarters

Center for Separations Using Thin Films  
Department of Chemical Engineering  
College of Engineering and Applied Science  
University of Colorado  
Boulder, CO 80309-0424  
Phone: (303) 492-7517  
Fax: (303) 492-4637  
Web: <http://spot.colorado.edu/~thinfilm/Home.html>

#### Center Co-Directors:

Dr. Alan R. Greenberg  
E-mail: [greenbea@spot.colorado.edu](mailto:greenbea@spot.colorado.edu)

Dr. William B. Krantz  
E-mail: [krantz@spot.colorado.edu](mailto:krantz@spot.colorado.edu)

Dr. Richard D. Noble  
E-mail: [nobler@spot.colorado.edu](mailto:nobler@spot.colorado.edu)

Center Evaluator: Dr. Virginia Shaw-Taylor  
P.O. Box 468  
Pinecliffe, CO 80471-0468  
Phone: (303) 642-0515  
Fax: (303) 642-0235